AN ABSTRACT OF THE THESIS OF

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Title: REGIONAL ARCHAEOLOGICAL MODEL OF THE
LUCKIAMUTE BAND SETTLEMENT PATTERNS

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Human settlement patterns are the ways in which people locate themselves over the terrain in their area of occupation. Settlement pattern prediction attempts to define and understand the factors in culture, technology, and environment that shape the spatial distribution of habitation sites for a given group of people. A systematic approach to the assessment of a region's prehistoric archaeological resources was conducted in this study. The study area was classified according to the suitability of its terrain for aboriginal settlement, ethnographic and archaeology data were collected, and a reconstruction of the prehistoric environment was completed.

Additional data from aerial remote sensors were gathered, as were the observations from ground reconnaissance. A collation and analysis of all available data was conducted, and a prediction of probable prehistoric settlement patterns was made based on polythetic settlement criteria. Of the numerous prehistoric sites located in this
study, none was apparently detected by aerial remote sensors. Many unfavorable factors exist in the Willamette Valley for the detection of prehistoric hunter/gatherer sites. These factors include dense tree canopy and vegetation on uncleared land, extensive plowing of agricultural lands which yearly decreases soil traces of prehistoric settlements, and a predominance of clay soils which have been observed in previous aerial photographic applications, to be poor in their ability to reveal past soil disturbance.

The systematic approach and settlement pattern criteria used in this study will be of value in the determination of prehistoric settlement patterns in the rest of the mid-Willamette Valley. Future studies of Kalapuya settlement patterns could be enhanced using this system. Protection and excavation of the prehistoric hunter/gatherer sites present in the study area is the desired product of this research.
Regional Archaeological Model of the Luckiamute Band Settlement Patterns

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REGIONAL ARCHAEOLOGICAL MODEL
OF THE LUCKIAMUTE BAND
SETTLEMENT PATTERNS

I. HUMAN ECOLOGY AND SETTLEMENT PATTERNS

The interaction, the relationship, between humans and their environment is complex. Through the past years, people have speculated at length about this relationship. Geographers and anthropologists have studied scores of cultures and climates throughout the world, through time. Geographers such as Ellsworth Huntington (1927) and Ellen Churchill Semple (1911) have suggested that environmental factors determine culture type and traits. They viewed the ecological setting of a culture as molding it. Huntington and Semple did not explain cultural traits of peoples who had migrated, or explain cultural change.

Anthropologist Clark Wissler (1926) discussed the relationship between culture and environment. He was not an "environmental determinist" as many previous writers had been. The importance of human culture in the perception of environment and its utilization was explained by him. White and Renner (1936) were among the first geographers to coin the phrase "human ecology." They were cultural geographers, interested in regional geography, who had a very different concept of human-environment relationships than geographers just 10 years before them. They were in many ways "cultural
Human and environmental relationships were explored by many anthropologists after World War II. Julian Steward (1955) discussed in detail the interaction between human culture and environment. His work centered on the importance of environmental factors in the shaping of many facets of a culture. He argued for a balance between environment and culture in determining human adaptations. His work was specific and dealt with the Shoshoni of Western North America. The effects of environmental change on human culture was explored. Steward's work was extremely valuable in clarifying human ecological theory.

Steward was among the first, in anthropology, to attempt to explain past settlement patterns based on the environmental, cultural, and technological factors of a human group. The analysis of Shoshoni adaptation to the arid environment they inhabited was a human ecological model.

Recent anthropological emphasis has revealed "more comprehensive and materialistic bent." One of the first comprehensive regional studies of human ecology was conducted by William F. Fitzhugh (1972). This work was in many ways an example of what can be done in regional human ecological modeling. Fitzhugh clearly describes important aspects of the human-environment relationship thus:
One of the fundamental assumptions in the study relating man to his environment is that man is part of an ecosystem, that he cannot live without it, and that he is in part limited by the environment or by the extent of his ability to alter it. A second assumption is that culture can be analyzed as a superorganic system and that it is man's chief means of survival, resulting in successful adaptations in almost every conceivable portion of the globe. Culture is, therefore, an adaptive system which articulates with the environment through a complex set of patterned relationships.

Fitzhugh notes that one of the most important aspects of human ecology is the subsistence-settlement system of a culture. The primary determinates to this system are the culture's technology, economy, regional geography, climate, and resource potential.

Settlements are primarily the result of a conscious decision to locate near certain resources. The primary considerations in the determination of location of prehistoric settlements were most probably proximity to water sources, and food resources. The technological development of a culture also determines how that culture alters the natural environment, and how independent it is from the natural limitations of an ecosystem. This degree of freedom from natural limits of that area influence settlement locations of a culture.

With the possible exception of caves, most of the permanent settlements of non-agricultural cultures (non-hydraulic agricultural societies are also included) are located in alluvial valleys (Gladfelter, 1977). The relationship between site location and resource location is one of distance, length of travel time, and the amount of work
involved to reach needed resources. When dealing with these types of cultures, certain spatial considerations were in play when site locations were chosen. These considerations are: 1) horizontal distance to water, 2) vertical distance (change in elevation and steepness) to nearest water, 3) distance to observation points, 4) distance to hunting areas, 5) distance to food resources (Wood, 1978). As there are different types of sites, the considerations may vary to some extent. Seasonally occupied sites will be located near specific resources which were utilized at that time of the year.

The necessity of knowing the seasonality and the role of numerous archaeological sites in a region requires the systematic collection, collation, and analysis of a wide variety of data. Floral and faunal resources, seasonal changes in food resource type, climatic changes, and groundwater availability would be critical factors in past settlement strategies (Parsons, 1972).

Hunter/gatherers have tended to take advantage of alluvial valleys and terraces for their year-round settlements, where water and food is usually more plentiful. The valleys and terraces provide a moderated winter microclimate, temperature ranges are less extreme than higher elevations. Alluvial valleys and terraces provided in many cases water, fishing, trade/communication routes, hunting, and floral food resources. Considerable variation in elevation and microclimates can also provide a great diversity of floral and faunal food resources.
Most nonagricultural (hunter/gatherer) cultures moved through the year, following the seasonal availability of food resources in their area. The need for most hunter/gatherer cultures to move periodically (although returning to the same locations) necessitated that they be mobile and they tended to not construct large, permanent buildings or architectural structures. There appears to be a general trend for the more sedentary cultures (agricultural) to leave behind large, permanent structures.

As development of land and water resources increases throughout the world, systematic inventories and surveys will be needed for many areas to insure preservation of past cultural material resources. Regional human ecological modeling of prehistoric inhabitants is needed to determine areas to be surveyed and protected. Valid regional human ecological models of prehistoric settlement patterns will need to utilize traditional archaeological techniques in addition to techniques from other disciplines that can augment the sometime more costly and slower ground survey methods.

An addition to the techniques used by Fitzhugh (1972) and others, notably Jeffrey R. Parsons (1972), and Robert L. Bettinger (1977), terrain classification and remote sensing could be of value in predicting past settlement patterns. The techniques then would include but not be restricted to: 1) ethnographic and archaeological data, 2) terrain classification, 3) hydrology data, 4) climate data,
5) floral/faunal resource prediction data, and 6) remote sensing interpretation.

A Regional Archaeological Assessment System

A systematic approach to regional settlement patterns would have as its goal the accurate prediction of prehistoric inhabitants of a region based on the best available data. A systematic approach to the settlement patterns of the prehistoric inhabitants of the study area of this research was conducted. The system, termed the Regional Archaeological Assessment System (R.A.A.S.), is depicted in Figure 1.

This system would in optimal circumstances follow a progression of steps from the top to the bottom of the diagram in Figure 1. The aspects of each step (or factor) for the determination of the subsistence-settlement pattern of the region’s prehistoric inhabitants will be briefly described and in following chapters, examples can be drawn by the applications made in this study on the Luckiamute Band of the Kalapuya.

The first phase in the system is the delineation of the boundaries of the region to be studied. Several criteria should be considered when possible in deciding what areas to include or exclude from the region. These are: 1) physiographic and drainage
Figure 1. Regional Archaeological Assessment System Diagram.
basin characteristics, 2) biotic and climatic characteristics, and 3) ethnographic data.

The second phase includes terrain classification of the region, acquisition of available ethnographic and archaeological data, and a reconstruction of the past environment. The terrain classification would have as its goal the delineation of geomorphic landform types that have a higher probability of having been suitable for settlement. Terrain classification systems have been developed primarily by geomorphologists and engineers over the past 25 years. Among the first terrain classification systems was one developed by Wood and Snell (1960) for the U.S. Army. Their system was devised and tested in central Europe. The system uses several terrain characteristics, such as relief, average slope, and slope direction change. Their system was orientated towards tactical military considerations, especially troop and vehicle movement.

Terrain classification systems have fallen into three general types: parametric systems, nonparametric and composite systems. Parametric terrain classification systems are quantitative, in that actual measurements on aerial photos, maps or on the ground are made. Parametric classifications can vary in the amount of detail and measurement that's involved. Many recently devised parametric classification systems are quite detailed and suited primarily for small-area engineering studies. Parametric terrain classification
systems are well suited to automated data storage and retrieval systems (Mitchell, 1973).

A second type of terrain classification system is the nonparametric type. It is usually more generalized, orientated to provide terrain classifications for land-use planning. This type of qualitative terrain classification can also include vegetation, hydrology, and wildlife. Ian McHarg (1971) has used this type of terrain classification system to its optimum.

A third type of system for classifying terrain is a composite of the parametric and nonparametric types. For use in predicting probable prehistoric settlement areas, a composite terrain classification system is probably best suited. This composite form of terrain classification provides the generalized landform delineation needed for settlement factor consideration and a quantitative parametric measurement of slope. This slope determination is also helpful in classifying terrain suited for settlement as Gladfelter (1977), Wood (1978), and Bettinger (1972) thought necessary.

Included in the second phase is the determination of what probable types of cultures inhabited the area prehistorically, and who the people were. All available ethnographic and archaeological data of these prehistoric inhabitants should be collected. Especially important in this case would be the type of economy, seasonal movement, and settlement locations (Ames and Marshall, 1981). The data should be
searched for clues to the types of floral/faunal resources utilized, types of shelters/houses built, settlement size, and other criteria mentioned previously in settlement pattern predictions.

Prehistoric environmental reconstruction is also a part of the phase of R.A.A.S. Available climate, hydrology, floral, and faunal information that exists or can be collected from existing data should be acquired. Hydrologic data such as past river meandering, old river courses, and changes in annual precipitation should be used. The determination of a reliable estimate of the environment that prehistoric inhabitants adapted to is highly desirable. If climatic changes have occurred in the study area, then, tree ring analysis, pollen analysis, computer climate modeling, and old historical records should be utilized. By possessing a fairly accurate estimate of what flora and fauna were located in the study area, potential food resource estimates can be made, as well as, seasonal movements of the inhabitants to best harvest those resources.

Based upon the information gathered in the previous steps, factors important to the prehistoric inhabitants of the study area that would influence settlement type and location are determined. These environmental criteria of prehistoric settlement would be similar to those used by Williams, Thomas, and Bettinger (1973) in their Reese River study. The criteria they used were: 1) distance to water, 2) distance to ecozone, 3) elevations above valley floor, and 4) percent of
slope (not greater than 5%). The portions of the study area that meet these criteria are delineated on a map and will possess a good probability of having prehistoric archeological sites located on them. The delineation of high probability areas of prehistoric settlement is the goal of the Regional Archaeological Assessment System.

The other aspects of the Regional Archaeological Assessment System include the use of random sampling techniques, remote sensing reconnaissance, ground reconnaissance, archaeological site testing, regional settlement pattern prediction, and cultural resource management guidelines for the areas of predicted/located archaeological sites. These will be discussed in later chapters.
II. REGIONAL ASSESSMENT

The Study Area

The area of study is bounded as such by these limits:

a) Northern Boundary = 123° 15' W, 47° 30' N to 123° 07' 30" W, 47° 30' N,

b) Southern Boundary = 123° 15' W, 44° 37' 30" N to 44° 37' 30" N and intersection of Willamette River,

c) Western Boundary = 123° 15' W longitude,

d) Eastern Boundary = Willamette River.

The study area is delineated on Figure 2.

The study area is on the western portion of the mid-Willamette Valley. It is probably fairly representative of most of the Willamette Valley in regards to vegetation, climate, terrain, hydrology and prehistoric settlement. The study area encompasses approximately 70 square miles.

The size and location of the study area was chosen because of its close proximity to the Corvallis area, its fairly representative character (of most of Willamette Valley), the financial and time limitations.
Figure 2. The Study Area.
Environmental Reconstruction

Prehistoric Geography

The Willamette Valley is a broad structural syncline orientated north to south, between the Cascade Range and Coast Range of Oregon. It is approximately 200 kilometers long in the north to south axis, with an average east-west width of 70 kilometers. The landforms of the valley are characterized by broad alluvial terraces separated by hills, rivers, and floodplain (Franklin & Dyrness, 1973). The valley floor has a slight slope, with the elevation slightly higher at Eugene (129 meters above sea level) than Salem (50 meters above sea level). This slight slope results in the Willamette River being a sluggish, mature river.

The study area is bordered on the east by the Willamette River, and portions are seasonally flooded. The geology of the study area is moderately complex, with recent Quaternary alluvium predominating. The area is probably geologically quiet, although a portion of the Corvallis fault is located in the study area. The hills are a mix of Eocene age sedimentary and volcanic rock. No known Quaternary volcanic activity has occurred.

The study area is predominantly composed of thick, alluvial sediment deposits of Plio-Pleistocene age. The entire Willamette
Valley was drowned by water and partially filled with silt to a depth of 30 meters following the Illinoian glaciation. Approximately 12,500 years ago the valley was again flooded in a massive flood from glacial Lake Spokane. Glacial erratics and silt were deposited to an elevation of 120 meters during this flood.

Soils. Soils in the study area have been derived from silty alluvial and lacustrine deposits under the formative processes of grassland vegetation. Soil morphology is primarily a result of landform position and drainage characteristics (Franklin and Dyrness, 1973). Of particular interest is poor soil drainage characteristics of most floodplain soils. Terrace and low hill soils generally possess good soil drainage characteristics.

An excellent summary of Willamette Valley climate, fauna, and flora is presented by White (1975).

Climate. The climate of the Willamette Valley presently is considered to be semi-humid marine. Approximately 70 percent of the annual precipitation falls from November through March. Less than 5 percent of the annual precipitation falls from June through August. In the study area, almost all the precipitation falls as rain. Summers are moderately warm and dry, with winters cool and wet. The deep water table is recharged annually by the precipitation.

Precipitation amounts are higher in hilly, upland areas and lower in the mid-Valley floor. The study area presently averages
40 inches of precipitation annually (Knizevich, 1975).

As limited meteorological records exist, palynological studies are needed to estimate prehistoric climate. A few pollen studies have been conducted over the years, by Hansen in 1941-42 and 1947, and Heusser in 1960. The results of these palynological studies are not comprehensive but are presented on figure 3.

The Willamette Valley was not glaciated during the Pleistocene. Extensive mountain glaciation occurred in the Cascade Range, but none reached into the valley. Following the end of the Pleistocene's last glacial retreat, the Anathermal or Early Postglacial period occurred in the valley (White, 1975). This was approximately 10,500 to 8,500 years Before Present (B.P.). The climate was generally drying and warming compared to the period of glaciation. It is likely that the climate at the end of the period resembled today's.

After this period terminated, the Hypsithermal or Middle Postglacial period occurred. This was approximately 8,500 to 3,000 years B.P. The climate was generally warm and dry, drier than at present. River and stream levels would have been lower. It is probable that oak growth was at its maximum at this time in the study area.

The Hypsithermal period ended and for the past three-thousand years, the climate of the Willamette Valley has been relatively the same as its present one. This period is referred to as the
Hypothermal or Late Postglacial.

The significance of the climatic changes in the Willamette Valley over the last 12,500 years upon human settlement patterns has not been discussed in detail in previous works. The lack of detailed palynological data may be the major cause of this. There are some controversial lithic finds that point to human occupation of the Willamette Valley in Clovis or post-Clovis times. It would appear reasonable that humans were living in the study area in the Anathermal period. The climate would not have precluded this. Figure 3 delineates climatic change in Western Oregon.

The increase of precipitation amounts on an annual basis would have increased erosion and deposition rates in the Willamette Valley. Vegetation and fauna probably would have been different. A drying and warming of the climate would have created a change in vegetation, hydrology, fluvial processes, and fauna. Further archaeological excavation and analysis is the primary method that will be used in the future to ascertain how climatic change altered the human adaptation in the Willamette Valley.

**Hydrology.** Maximum river discharge on the Luckiamute and Willamette Rivers occurs in winter between December and March. The general climatic regime of heavy winter rainfall and a dry summer has been present in the study area most likely for the past 12,500 years. It is probable that winter flooding has occurred during this
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<tr>
<td>12000</td>
<td></td>
<td>spruce fir</td>
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Figure 3. Climate Change in Study Area. (combined sources)
time and summer low river levels have been the rule also. The relevance of these factors to human settlement will be discussed in Chapter IV.

The existence of springs has been detected by aerial photography, topographic maps, and ground observations. The geology of the hills in the study area would allow for some springs, primarily on the slopes of the hills west of highway 99W (Eocene basalts). The sandstone and siltstone composition of the hills east of highway 99W would not be as permeable, and would tend to have less springs. It is probable that these springs in many areas would have provided year round sources of freshwater.

Prehistoric Vegetation

Much information has been presented in previous archaeological works on Kalapuya sites in the Willamette Valley, about the vegetation that exists in the valley now. Little reconstruction of prehistoric vegetation has been attempted by archaeologists. Probably this has been due to a lack of data.

Recent work on tracing the late prehistoric vegetation of the Willamette Valley was completed by Jerry Towle (1974), a historical geographer. A map of the study area's vegetation in 1853 is presented on Figure 4. This map is based primarily upon the land surveyor's notes and transects, when the Willamette Valley was surveyed in 1852.
Figure 4. 1853 Vegetation Map.
to 1854. These observations on vegetation are probably fairly accurate (Towle, 1974). The map reveals that extensive tracts of prairie-grassland existed. It was suggested that prior to 1844 these prairies were 10% larger, and that the lack of annual Native American field burning in the intervening years allowed the forests to enlarge in area.

It is probable that the climax vegetation for the Willamette Valley is, for its present climate, western hemlock (Tsuga heterophylla). It also is likely that the climate fosters tension between Douglas fir (Pseudotsuga menziesii) and white oak (Quercus Garryana), which are presently at an equilibrium. Any significant increase in summer precipitation would increase the density of Douglas fir as a sub-climax to western hemlock. A decrease in annual rainfall would likely cause an increase of oak-grassland, savanna (Towle, 1974).

Early descriptions by Euro-Americans of the Willamette Valley are recounted by Towle (1974). Most of these accounts describe the open, savanna landscape that many attributed to human management (Kalapuya). In 1826, a professional botanist named David Douglas traveled through the Willamette Valley and described the abundance of camas and oak trees. Other travelers described the camas abundance as:

In places, the camas formed virtually pure stands over ten or twelve acres. The strawberry (Fragaria) was abundant in the drier prairies ... (Towle, 1974).
The prairies were primarily dependent upon the annual field-burning by the Kalapuya. The historical record has numerous accounts of these activities.

Due to the fairly arid conditions that prevail during the summer months, cedar grows in relatively low abundance in the Willamette Valley. Lodgepole pine also was present in the valley prior to Euro-American settlement, with its climax of growth occurring in the Anathermal period.

Riparian woodland vegetation included red willow (*Salix lasiandra*), Oregon maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia/Oregana*), and alder (*Alnus rubra*) in bottomland/floodplain plant communities (Franklin and Dyrness, 1973; and White, 1975). These trees provided wood resources for prehistoric use.

The prairie-grassland areas probably were composed of bunchgrass, needlegrass, tarweed (*Madia elegans*), camas, and California poppy (*Eschscholzia californica cham*) (Towle, 1974). Wild sunflower was observed in relative abundance by several early Euro-American travelers.

The general impression of early travelers of human management of Willamette Valley vegetation is confirmed by archaeological evidence. The exact reasons are presently not well-understood for this field-burning. The vegetation present in prehistoric times would have provided many food resources which would have included: camas
(probably harvested late spring to early summer), tarweed (probably harvested late summer to early fall), cattail, wapato, sunflower, acorn, hazelnuts, wild rose, oregon grape, wild onion, wild berries (blackberries, strawberries, etc.).

**Prehistoric Fauna**

Early Anathermal animal inhabitants of the Willamette Valley probably included mammoth, ground sloth, camel, smilodon, and giant bear, many characteristic megafauna of cold environment. As the climate (and vegetation) changed, these animals apparently died off. Possibly these animals were aided to their extinction in the Willamette Valley by human hunters.

From late Anathermal times to Euro-American settlement, the largest animal inhabitant of the Willamette Valley has probably been the Roosevelt elk (*Cervus canadensis roosevelti*). These animals often weigh as much as 650 kilograms, were observed in large numbers by early Euro-American travelers. They apparently favored the prairies and edges of woodlands. (Towle, 1974).

The blacktailed deer (*Odocoileus columbianus columbianus*) also inhabited the study area prehistorically in relative abundance. This species favored dense forest and underbrush. In winter they tend to occupy foothills and summer in higher elevations. They do not favor band behavior and can weigh up to 100 kilograms (White, 1974).
The white-tailed deer (*Odocoileus Virginianus leucurus*) was very plentiful in the Willamette Valley. The white-tailed deer apparently preferred the dense woodlands in narrow valleys and riparian vegetation near water courses.

The list of animal species inhabiting the Willamette Valley in prehistoric times includes:

(a) Washington snowshoe hare (*Lepus americanus washingtonii*),

(b) Oregon brush rabbit (*Sylvilegus bachmani ubericolor*),

(c) Oregon Coast muskrat (*Figer zibethicus occipitalis*),

(d) Pacific Coast beaver (*Castor canadensis pacificus*),

(e) Pacific mountain beaver (*Apolodontia rufa pacifica*),

(f) camas pocket gopher (*Thomomys bulbivorous*),

(g) Oregon cougar (*Felis concolor oregonensis*),

(h) western otter (*Lutra canadensis pacifica*),

(i) Klamath Grizzly (*Ursus klamathensis*),

(j) Olympic black bear (*Ursus americanus altifrontalis*),

(k) Wood duck (*Aix sponsa*),

(l) golden eagle (*Aquila chrysaetos*),

(m) ruffled grouse (*Bonasa umbellus*),

(n) California quail (*Lophortyx californicus*),

(o) Canadian geese (in late fall-early spring);

Also present were salmon, trout, eel, and freshwater molluscs (White, 1975).
It must be mentioned that only elk, bear, deer, beaver, bird species, and some mice remains have been excavated from Kalapuya settlements. Little knowledge had been collected of Kalapuya food taboo's. The poor faunal record is largely the result of poor organic preservation. It is probable that most of the listed animal residents of the study area were utilized by the Luckiamute as food.

Using the generalized habitat descriptions for the listed animal residents of the study area, it is possible to map the probable late prehistoric habitats of floral/faunal food resources. Figure 5 depicts these habitats in summer months, Figure 6 depicts the habitats in winter months.

Summary

The study area, in prehistoric times, probably contained an abundance of floral and faunal food resources. The exact extent of these food resources would be impossible to be determined from existing data. It is very probable though, that the study area contained enough food for many of the Luckiamute bands.

Ethnographic Data

The only known prehistoric inhabitants of the mid-Willamette Valley were the Kalapuya, a member of the Penutian linguistic phylum. It is further believed that the Luckiamute band of the Kalapuya occupied
Figure 5. Potential Floral/Faunal Habitats - May thru November.
Figure 6. Potential Floral/Faunal Habitats - November thru April.
the study area, and that the Luckiamute had approximately 8 bands, which included:

1) Ampalamuya 5) Tsalakmuit
2) Chantkaip 6) Tsantatawa
3) Chepenofa 7) Tsantuisha
4) Mohawk 8) "Marys River" (Collins, 1951).

Virtually nothing is known of the Luckiamute sub-division of the Kalapuya. No archaeological sites have been tested or excavated in the study area. Within 3 miles (to the Northwest corner) of the study area a prehistoric hearth was carbon-dated to over 5,500 years before present, but it was not archaeologically tested. Most of the ethnographic data on the Kalapuya was taken from interviews of a few survivors, over 50 years after widespread disease had virtually destroyed the Kalapuyans. The interviews were of people of Kalapuyan ancestry who had not lived in the traditional manner but had been "westernized." Much of the data have been supplemented by archaeologically derived data from excavations of Kalapuya sites. Unless otherwise stated, the ethnographic data refers to other sub-divisions of the Kalapuya, who were known to have had very similar language, beliefs, and culture as the Luckiamute. The assumption has been made, out of necessity, that the Kalapuyan sub-groups were very similar.

The ethnographic and archaeological data that relates to settlement patterns, settlement seasonality, settlement type/size, and food
resource use are particularly critical. Also important are economy, trade, and burial customs. For the purposes of clarity, different topics of importance to the RAAS approach will be discussed.

**Housing**

The Kalapuya had several different words referring to houses they used. They differentiated between summer houses and winter houses, between plank houses and earth-winter houses (Zenk, 1976). Building materials available in the study area would have included felled Douglas fir, oak, lodgepole pine, and some scattered locations of cedar. Both the bark and wood were utilized.

Numerous accounts by the early explorers and settlers who had traveled in the Willamette Valley include references to Kalapuya houses. Winter houses were described as from 40 to 50 feet long, with two to four families in a house (Zenk, 1976). Sitting and sleeping were done on shelf-like planks with excavated leg-room. Other accounts describe a pit-house of ovoid or square shape with entry through side or top entrances (Collins, 1951 and Jacobs, 1945). It is probable that both types of housing were used.

The Kalapuya also extensively used sweathouses for personal hygiene and for the sleeping quarters of boys and girls. These sweat-houses were from the side, dome-shaped, and of circular or semi-circular shape in foundation. Framework was usually of soft, green
hazel-sticks, with a covering of fir boughs and moist dirt. Cobbles were used to heat the sweathouse, after being heated in a fire outside.

All housing was temporary, as far as is known. No permanent architectural structures were built as twentieth-century Americans understand. Even the winter pit-houses, and plank-houses were usually utilized for less than 10 years and left to deteriorate. The amount of change to surface soil would be considerable for some time after the collapse of a pit-house or plank-house. It is suggested that probably after 50 years, only a slight increase of soil organic content would be noted over the site of an undisturbed pit-house or plank-house. Fire cracked rock and lithic debris would last longest.

Summer houses of the Kalapuya were described by accounts (Zenk, 1976; Collins, 1931) as being "lean-to's." These temporary shelters would have had little long-term effect on the environment.

Economy

The economy of Kalapuya was essentially hunting and gathering. They gathered acorns, nuts, berries, camas, and other floral food resources. Males hunted elk, deer, small game, waterfowl, and fished for salmon (Collins, 1951).

Camas was widely distributed in the floodplains and swales of the entire Willamette Valley. Accounts of the early settlers also recount how abundantly camas grew, with 10 to 12 acre stands fairly
common. The camas was harvested by Kalapuya women from May to July. The camas bulbs were dried/baked in open-hearth ovens and kept year-round. Often this camas was traded to tribes from the coast and interior (Zenk, 1976). It is highly probable that there was an overabundance of camas in the Willamette Valley, and that the Kalapuya traded it to some extent or another. Its location was such that no special settlements were needed to utilize it. Camas was probably located within easy walking distance of winter village sites.

Hunting of the plentiful supply of elk and deer was done by the males. It was probably less important as over-all diet than gathering and fishing. Among the other animals the Kalapuya hunted were included beaver, rabbit, squirrel, and numerous waterfowl. Deer and elk were communally and individually hunted. A "circle hunt" was used to hunt deer and elk (Ratcliff, 1973). Traps were used on beaver, rabbit and squirrel. Waterfowl were hunted usually by nets, a far more effective and efficient method than bow and arrow.

Fish provided the greatest portion of animal protein to the Kalapuya diet. Salmon, trout, and eel were extensively used. It was probable that Kalapuyans shared fishing rights at the falls at Oregon City during fall salmon runs. The confluence of major river systems were also ideal spots for fishing sites.

Kalapuyans apparently regularly burned large areas of the Willamette Valley. Among the many reasons for burning are these:
1) harvesting of tarweed in late summer necessitated field burning,

2) hunting elk in methods that used fire to congregate and guide the herd,

3) preventing the oak forest from taking over the Valley by burning each year to keep down the forest cover. As only the young oak are very vulnerable to fire, oak had to be contained to allow the open grasslands for elk to graze on. If this particular human intervention into the ecosystem was caused by a desire to provide an optimum environment for elk, then the Kalapuya may have been practicing the beginnings of animal domestication.

4) by field burning in late summer-early fall, the new, grass shoots were attractive as food to fall-migrating Canadian geese. By providing this "lure," the Kalapuya were able to very effectively hunt these geese.

It is probable that all these factors had interplay for the reasons for Kalapuya field-burning. A description of the vegetative and animal food resources available in the study area is given in the next section.

Transportation/Trade

The Kalapuya did not apparently possess horses. The primary means of transportation was by foot and by canoe. It is highly probable
that watercourses and alluvial valleys were the routes of transportation. Canoes were apparently of both dugout and fired variety (Collins, 1951). Some accounts by early explorers place canoe size from between 20 to 50 feet in length. For the transportation of family members, of goods, and trade items, it seems likely that the canoe was most suitable. The Willamette River and its major tributaries would have been ideal routes of water transportation.

Canoes were also used in fishing, as evidenced by the clubs and harpoons used by the Kalapuya. The abundance of Douglas fir, alder and other trees in the Willamette Valley provided a very adequate source of raw material.

Settlement Type and Pattern

The Kalapuya settlement system apparently was related very closely with the abundant food resources located in the Willamette Valley (Brauner and Honey, 1976). The Kalapuya probably were a "two-season" people, the late fall-winter-early spring was when they occupied the more protected winter-house and in late spring-summer-early fall many lived in open, airy lean-to shelters. This dual division of the year by most Kalapuya mirrored their subsistence activity.

Zenk (1976) states:

... the part of the year during which temporary camps were occupied coincided with the period of peak harvest activity; on the other hand, harvest activity was at a
minimum during the winter season, especially during the coldest part of winter when spirit-power dancing and myth recitation were predominant activities.

This division of the year would indicate the probability that two or more habitation sites were utilized by the Luckiamute on an annual basis. White (1975) proposed four types of Kalapuya habitation sites based on ethnographic and archaeological data. These are:

1) Type 1--Valley Edge Sites, activities centered on spring and summer hunting/grinding activities,

2) Type 2--Narrow Valley Plain Sites, activities centered on spring and summer grinding activities,

3) Primary Flood Plain Sites, activities centered on year-round camas gathering and hunting,

4) Riparian Sites, activities orientated to year round hunting, grinding, and fishing.

These divisions of sites by White are primarily based on the seasonality factors of Luckiamute resources. It is also apparent that proximity to water, and slope are important factors that played an important part in settlement location. Another important consideration for the locations of Luckiamute winter village sites would have been winter flooding. Winter villages (Riparian Sites) would have been located above the flood levels of the rivers and streams of the study area. It is also probable that the winter-village settlements (Riparian Sites) were occupied year-round.
Settlement Size

No one has any reliable data on population size, density or age for the Kalapuya. Estimates of Kalapuya population density have ranged through the years from 600 to 10,000 prior to the 1830's. It is probable that the population of the Kalapuya could have been well over 10,000 for the Willamette Valley because of the abundance and stability of floral/faunal food resources. The smallpox and malaria epidemics (Cook, 1972) of the late eighteenth and early nineteenth centuries devastated Kalapuyans. Well over 75% of Kalapuyans died, probably causing irreversible damage to their culture and economy.

Estimates of the pre-epidemic population vary; Kroeber (1939:136) cites a total population for the Valley of 3,000, a density slightly less than nine per one hundred square kilometers. This figure would make the Willamette Valley one of the most sparsely populated regions of the Northwest, with densities only slightly greater than those of the wooded Cowlitz Valley, and up to sixteen times lower than those of the lower Columbia. These same estimates give the Central Valley of California densities seven to ten times higher. It would seem that this disparity, given the resource base of the Willamette, is extreme.

The band size of the Luckiamute may have been from 20 to 35 people in size, probably an extended family. The Luckiamute reportedly had 8 bands during the late 1700's, making a Luckiamute
population of between 160 to 280 people. The informants were not specific about when these data were true, it may well have been post-contact period. It is possible that band size seasonally fluctuated, as different people went off to harvest food resources. Population settlement density, and settlement size data must be regarded as having serious gaps. Potentially, future archaeological excavations may be able to fill in these gaps.

Terrain Classification of Study Area

Objectives

The objective of classifying the terrain located in the study area was to delineate areas that may be too steep for permanent human settlement and to differentiate various terrain types such as floodplains, watercourses, ridge crests/saddles, and alluvial terraces. The terrain classification would be a composite classification, using parametric measurements of slope and landform classification of other features. The source materials should be generally available items in the U.S.A. with the classification oriented to the needs and goals of this study, i.e., a reliable estimation of general terrain characteristics in the study area.
Methodology

Source materials for the composite terrain classification of the study area included:

1) U.S. Soil Conservation Service Maps and Aerial Photography (scale 1:20,000; Knezevich, 1975);
2) U.S. Geological Survey Topographic Quadrangles (scale 1:24,000);
3) Previously flown U.S.S.C.S. Aerial Photography (Vertical, 1:12,000);
4) Side Looking Airborne Radar imagery (scale approx. 1:90,000);
5) Lewisburg Quadrangle Geology and Geologic Hazards Map, 1979 (scale 1:24,000);
6) Ground observations and notes.

From these materials, key factors were determined. These factors were the criteria used to classify the terrain. These categories of terrain, and the criteria for each were:

1) "ALLUVIAL TERRACE, VALLEY FLATLAND."

These terrain features have a slope from \(\approx 0^\circ\) to \(3^\circ\), less than 500 feet above mean sea level, terraces can be on top of hills. Must be out of seasonal floodplain of 100 year flood. Small, isolated, depressions or elevations of less
than 100 meters in diameter may be in this category. On topo. maps this terrain category will be generally 8 to 10 meters above mean river levels. Aerial photography will reveal this area in stereoscopic viewing by its gentle slope or flatness.

2) "RIDGE CRESTS, SADDLES, HIGH TERRACES"

Ridge crests identified from aerial photography, soils map and topographic maps with less than 10° slope above 250' AMSL are included in this category. Terraces on the sides of hills/mountains, and all terraces above 500 feet AMSL are included. Saddles between hill/mountain tops are also included, if their slope is ≤ 10°.

3) "GENTLE INCLINE"

Gentle inclines are hillslopes, mountainslopes, depressions with a mean slope of less than 10° but more than 3° that do not fit into the category of Ridge Crest, Saddle or High Terrace. Slope was measured at Azimuthal transects of every 22.5° from True North, every 200 meters of horizontal distance. This approximation was made from elevation contour lines of USGS topo. quads, with a slope template. The slope template had an estimated error of ±2°, which provided an acceptable estimation of slope for the needs of this type of terrain classification. Additional
identification of slope was made with vertical, aerial photography viewed stereoscopically, and the interpretation of available Side Looking Airborne Radar (S.L.A.R.) imagery of the study area. The characteristic of SLAR as an excellent sensor of terrain relief was extremely helpful as a supplemental source of slope data from the topographic maps. Areas too small to be identified on topographic maps and remote sensing imagery was estimated to be approximately 20 meters in diameter.

4) "STRONG INCLINE"

Using the same techniques described under Gentle Incline for slope determination, these inclines had over 10° of average slope.

5) "PROBABLE SEASONAL FLOODPLAIN"

These areas were less than approx. 8 meters above the average level of water bodies indicated by the USGS topo. quads. These areas are prone to winter flooding and/or high water. These areas are usually located near 1st and 2nd order streams, and rivers. These areas were determined by topographic map interpretation, soils maps and soils data, aerial photointerpretation, and available hydrologic records. Additional ground observations were made in conjunction with aerial photography acquired during
floods. Many of these areas are the locations of recent erosion and deposition by fluvial processes. Numerous ox-bow lakes and river meanders are present in these areas.

6) "STREAMS, RIVERS, WATERCOURSES"

These are present watercourses or probable, past watercourses. These areas are usually less than 5 meters above present, adjoining, watercourses, as depicted on topographic maps. Map interpretation, aerial photointerpretation, and soils map interpretation were used to delineate this category of terrain, especially in the determination of past, watercourses. Past river meanderings were relatively easy to identify due to the usual presence of oxbow lakes, and erosional surfaces such as old river banks. Soils maps and information from the SCS were extremely useful due to its approximate dating of soil types.

7) "RECENT MUDFLOWS AND SLIDES"

These are areas of recent (approximately past 50 years) erosional activity. These areas are usually larger than 100 meters in diameter to be detectable and noteworthy. Their presence was determined mainly from geological hazard study maps, and soils maps.

For the terrain classification, the minimum terrain unit was a
square 15 meters on each side. Terrain within each 15 meter square was classified in slope and according to the previously mentioned factors. This still provides a fairly accurate estimation of the terrain characteristics of the study area for the prediction of prehistoric settlement patterns.

Results

Figure 7 depicts the completed terrain classification of the study area, using the methods and categories described previously.

Discussion

Every type of terrain classification system has a different objective and goal for its use. The variations of the goals accounts for the many different forms of systems. Engineering systems would be vastly different than military systems, and agricultural development terrain classification systems would be different from forestry oriented systems. The terrain classification needs of archaeology are also different. The overall goals of archaeological systems of terrain classification might have these goals:

1) the generalized configuration of terrain types,
2) location of alluvial valleys and terraces,
3) delineation of areas unsuited to year round settlement, such as, floodplain, steeply sloped areas, etc.
A detailed, quantitative terrain classification system is probably not necessary.
Figure 7. Terrain Classification Map.
III. PREHISTORIC SETTLEMENT PATTERN CRITERIA AND HUMAN ECOLOGY MODEL

Previous Work

White (1975) divided Upper Willamette Valley prehistoric sites into four types based on their environmental and geographic situation. Inhabitant activities at these site types were inferred from ethno- graphic and archaeological data. Seasonality of these was also postu- lated based on analogies with present environmental characteristics.

The characteristics of these site types are described below, and they were used as the basis of the settlement/site criteria used in this study. A site is defined, in this study, as the location of pre- historic habitation.

"Valley Edge Sites"

Valley Edge sites were located above the 500 to 600 foot contour line in the Upper Willamette Valley. These sites would also be located on the ridges and crests of foothills. White (1975) stated that they were located close to small springs or spring-fed streams. It is probable that they were seasonally occupied mostly in summer months. They would have provided some refuge from mosquitoes that were plentiful in summer months. The principal activities carried out at these sites were hunting of large game and seed grinding.
"Narrow Valley Plain Sites"

These type sites, according to the criteria proposed by White, would probably not have been located in the study area. They would be located closer to foothill and mountain areas.

"Primary Flood Plain Sites"

As proposed by White, these sites would have these characteristics:

1) located on the flat floodplain of the Willamette River, and the old courses of the Willamette,
2) subject to seasonal flooding,
3) probably located on edges of oak woodlands and prairie grassland,
4) these sites had an abundance of floral and faunal food resources,
5) primarily occupied in late spring and summer, some possibly year-round.

"Riparian Sites"

According to White, these sites would be situated adjacent to the larger perennial streams and tributaries of the Willamette River. These sites would be off the floodplain, on alluvial terraces. Riparian
sites probably were occupied year round in many cases and probably were the location of pit-houses and/or plank-houses. Activities at these sites included the hunting of large game, grinding, and fishing.

White proposed that the prehistoric inhabitants probably split-up into smaller groups in spring and summer in order to accomplish the major task—camas gathering. Fall and winter, he speculated, would be when local communities regrouped and congregated in larger bands.

The distribution of the Upper Willamette Valley sites and their adjacent resources would point to the conclusion that the Kalapuya during the 2000 years before Anglo-American contact, practiced a settlement-subsistence pattern in which a broad spectrum of floral and faunal food resources were utilized. It is probable that strategically located base camps were deployment spots for the seasonally specific task of floral and faunal food resource acquisition. During the last 2000 years, archaeological and ethnographic evidence points to extensive trade contacts with coastal, interior and northern Native-American groups.

**Settlement Pattern Criteria**

A thorough, systematic reconnaissance has never been conducted of the prehistoric sites in the mid-Willamette Valley. Most known prehistoric sites were located by landowners or local pot-hunters. The statistical validity of the randomness of the known prehistoric sites is
not known, but as these data are all that is presently available, it was used for portions of the settlement criteria in this study.

A stratified sampling of the known prehistoric sites of the Upper Willamette Valley revealed that 97% of all sampled sites were located within 200 meters of a past or present water-source. Over 60% were located within 100 meters of the local, water source. The assumption that probably most (over 90%) Kalapuya settlements were located within 200 meters of a water source was chosen as a prime criteria for settlement. It is probable then that Kalapuyans settled within 200 meters of a water source. Ethnographic and archaeological data describes the use of bark and/or wooden buckets for the transference of water by the Kalapuya. It is probable the pre-Kalapuyan inhabitants would have utilized similar water acquisition technology.

Thomas (1979) used a settlement criteria of 1000 meters or less distance from settlement to water source, in an arid environment. Wood (1978) considered the horizontal distance to water as the most important settlement criteria in his human ecology model.

Another significant factor to be considered in the settlement strategy by all humans is the degree of slope upon which the settlement is to be located. Thomas (1979) noted that hunter-gatherer settlements are located rarely on steep or even moderate slopes, with 10° being the upper limit in most cases. Flat terrain or gentle
slopes are best suited for settlement location. The Kalapuya very probably did not construct semi-permanent or temporary settlements on slopes over 10°. It is probable though that if a steep slope were present between a water source and a flat, alluvial terrace, they would still settle. Probably vertical distance to water over 50 meters would have discouraged Kalapuya settlement. Wood (1978) also considered the vertical distance to the water-source as critical.

The flooding of rivers and low-land areas would have prevented year-round Kalapuya settlement in many areas. These settlement criteria were adequately addressed by White's (1975) discussion of Upper Willamette Valley site types and their characteristics.

Based upon White's (1975) site typology, and water distances, slope and flooding criteria, these site types (and criteria) were used in this study:

a) "Riparian Site Zone" (Year-Round Sites)

1) within 200 meters horizontal distance from a permanent tributary of the Willamette River,

2) within 50 meters vertical distance from permanent or semi-permanent water-source,

3) located on dry ground—such as alluvial terrace, at least 8 meters vertical distance above mean water level of river and streams,

4) located on relatively flat terrain (average slope less
than 10°), possible preference for southern exposures and easy canoe access to Willamette River.

b) "Primary Flood Plain Site Zone"

1) within 200 meters horizontal distance from permanent or semi-permanent water-source,

2) within 50 meters vertical distance from permanent or semi-permanent water-source,

3) located on relatively flat terrain (average slope less than 10°),

4) located on seasonal floodplain of Willamette River and major tributaries,

5) located near floral and/or faunal flood resource.

c) "Valley Edge Site Zone"

1) within 200 meters horizontal distance from permanent or semi-permanent water-source,

2) within 50 meters vertical distance from permanent or semi-permanent water-source,

3) located on relatively flat terrain (average slope less than 10°),

4) located over 400 feet (120 meters) above mean sea level,

5) located near floral and faunal food resources.

Figure 8 depicts the predicted site zones of the prehistoric inhabitants of the study area. The generalized prediction utilizes the data.
Figure 8. Settlement Pattern Prediction Map.
from the terrain classification, 1853 vegetation map, potential summer
faunal habitats, and the potential winter faunal habitats map.

It must be emphasized that these settlement criteria are provi-
sional due to the lack of statistically valid archaeological data to pro-
vide unbiased, factual, observation basis for these settlement factors.
These settlement criteria are deductive and are general estimates.
The possible refinements to these criteria by future work are purely
speculative. These proposed settlement criteria for the Luckiamute
(and Kalapuya in general) are still capable of providing sound estimates
of areas of probable settlement. These criteria provide a fairly
accurate representation of the subsistence-settlement factors utilized
by the Luckiamute.

As the characteristics of any pre-Kalapuyan inhabitatants of the
study area are speculative, no real attempt has been made to address
these people specifically. It can be reasonably assumed however, that
these people were hunter-gatherers, utilized many of the same settle-
ment criteria, that the climate has not changed all that much since the
end of the Pleistocene, and that these settlements, if they exist, would
be in older, soil strata than Kalapuya settlements.

When further climatic, vegetation, faunal, and geomorphic data
becomes available for the Willamette Valley, it is probable that addi-
tional refinements can be made to the estimation of the environment in
prehistoric times.
As further archaeological data becomes available, especially in the middle and lower Willamette Valley, it is probable that additional refinements will be made to the settlement criteria of the prehistoric inhabitants. It is desirable that in the future, a systematic and statistically random assessment of Willamette Valley prehistoric settlements be funded and completed.

The delineation of possible prehistoric settlement areas on Figure 8 is a generalization. Ideally, a map of 1:24000 should be used, as the better detail in terrain characteristics would provide a better base on which to delineate. Due to the requirements of thesis binding, a scale of approximately 1:62,500 is presented on Figure 8.

Areas of probable prehistoric settlement on Figure 8 (labeled "2") are based on present and past stream and river courses. As extensive soil erosion and deposition has occurred in these areas, there could be many geomorphic processes that would tend to hamper site preservation and detection. To a lesser extent areas delineated as possible riparian sites would have been negatively impacted over time by these processes, as would possible valley edge sites.
IV. REMOTE SENSING APPLICATION

Past Work in Archaeological Remote Sensing

Remote sensing is the acquisition of imagery with a sensor which may or may not be a conventional camera through which a scene is recorded. Besides standard visual wavelength cameras and film, such sensors as microwave, radar, thermal infrared, ultraviolet, multi-spectral, gravimeters, magnetometers, and soil restivity meters may be used to detect archaeological remains.

Aerial remote sensor imagery can provide a systematic means of searching out ground surface features. Remote sensor imagery itself constitutes a historical record as it is a permanent record of conditions that exist at a certain location, in space and time.

Since 1906, remote sensing has been successfully used in the analysis of known archaeological sites, the first use was a picture taken of Stonehenge by a military balloon (Aschmann et al., 1975).

In 1922, O. G. S. Crawford was one of the first archaeologists to use aerial photography to detect archaeological sites. By the end of the 1920's the British archaeological community was routinely utilizing aerial photography of Roman and Celtic sites (Aschmann, 1975).

The use of aerial photography in America was not as early or as intensive as in Great Britain. Among the first aerial
photographs acquired of an archaeological site in the U.S. were those taken by Army aviators of Cahokia Mound in 1921. Since that time, work had been conducted in North America sporadically until the 1950's, when aerial photography became used routinely in many areas. Important to this study is the fact that for over 50 years, aerial photography has been successfully used to detect archaeological sites around the world. Also of considerable significance is that the vast majority of remote sensing applications to site detection have been with agriculturally based cultures. Only a few past projects have dealt with the use of remote sensing imagery to detect the remains of hunter-gatherer cultures.

Of particular interest in the remote sensing of hunter-gatherer sites is the work of Carl H. Strandberg. He partially tested the various types of remote sensors as to their utility to archaeology (Strandberg, 1967). Strandberg successfully used aerial panchromatic photographs to detect hunter-gatherer sites. Strandberg was not able to test the sites he claimed that appeared on the aerial photographs in some cases. This lack of testing to determine size and character of the detected site is unfortunate, as it leaves the validity of some of his work in question.

Several village sites were tested and it has been determined that pit-house remains may be detected by remote sensing imagery. Also successfully detected were stone fish traps located in the
Strandberg determined that best site detection results were obtained with imagery of scales from 1:20,000 to 1:3,000, with 1:3,000 being optimal.

Recent use of remote sensing application to the detection of hunter-gatherer housepit features has been conducted by Dunnell (1978). Dunnell was able to detect housepit features in a known site location. Many of the site features were excavated and he discussed some of the factors inherent in remote sensing site detection in the Pacific Northwest.

Numerous successful remote sensing experiments have been conducted by the Anasazi settlements located in Chaco Canyon, New Mexico. These agricultural and pueblo remains have been detected with many remote sensors, including aerial panchromatic photography, aerial color infrared photographs, Side Looking Airborne Radar (S.L.A.R.) and thermal infrared imagery (Lyons and Avery, 1977; Ebert and Hitchcock, 1979; Gumerman and Lyons, 1971).

**Remote Sensor Types**

Some of the remote sensors successfully employed to detect archaeological remains are briefly described below. A comprehensive and thorough description of remote sensors is available in the *Manual of Remote Sensing* (Reeves, 1975).
Aerial Panchromatic Film

Aerial panchromatic photography has been used to detect archeological sites for over fifty years. This form of photography has a well-documented success rate in locating buried cultural material and sites. The film is sensitive to the visible portion of the electromagnetic spectrum, with some overlap into the near infrared and ultraviolet. The sensitivity of most panchromatic films is from 0.3 µm to 0.9 µm (Avery, 1977).

Aerial photography is usually acquired during times of the year when soil moisture and surface vegetation are most conducive to detection of subsurface artifacts. In the Pacific Northwest, the time of year with maximum soil moisture contrast is late summer. Time of day is also another variable that can influence the ability of aerial photography to detect subsurface archaeological sites. Many sites have caused slight changes in surface topography, as either a slight depression or rise. Aerial photography acquired early in the morning or late in the afternoon uses the low sun angle to highlight slight changes in topography with shadows. This technique has been highly successful.

Aerial panchromatic photography for use in detecting subsurface archaeological sites requires a scale of 1:7,000 to 1:20,000. The degree of ground resolution from these scales is ideal for
interpretation for site detection (Martin, 1971).

**Aerial Black and White Infrared Imagery**

Black and white infrared film has been available to aerial photographers for over twenty years. It is Kodak I.R. Aerographic Film 2424. This film uses standard cameras (with a special lens filter) to record reflected light in the near infrared spectrum (0.7 to 0.9 μm). It also records most of the visible portion of the spectrum, with the exception of blue wavelengths (Avery, 1977). This blue light is the portion of the visible spectrum that is frequently scattered by smog, air particles, and other atmospheric conditions. Black and white infrared imagery is thus able to penetrate many atmospheric conditions that would render color photography as hazy.

Black and white Infrared (I.R.) imagery is able to detect surface water and vegetation differences better than standard panchromatic film. It is well suited also in detecting the interfaces of surface water and terrain (Sabins, 1978). Black and white I.R. film thus requires no sophisticated sensor modifications, is stable at room temperatures, and does not cost much more than standard panchromatic film.

**Color Infrared Imagery (Aerial)**

Color infrared film (Kodak Aerochrome IR Film, Type 2443) was
designed to detect variations in vegetation. It is not sensitive to the blue portion of the spectrum and does not require special modifications to existing cameras to be operable. Color IR film is also very sensitive to surface water differences and is able to detect surface geology (Sabins, 1978). Archaeological subsurface sites influence the composition and moisture content of the overlying soil, which in turn affects the reflectance of the vegetation. This change in vegetation reflectance is then detected by the color IR film.

Even in dense vegetation, color IR imagery was able to detect certain types of archaeological sites (Gumerman and Neely, 1972). Only forest canopies that cover surface vegetation place some restrictions on the use of color infrared. Possibly out of all sensors currently available, Color IR imagery is the most versatile. It can detect the variables of soil moisture detection, vegetation change detection, and vegetation pattern change (Gumerman and Lyons, 1971).

Aerial Thermal Infrared Detectors

These sensors detect emitted surface infrared radiation in the spectral range of 3.0 to 14.0 μm. Thermal IR sensors (Thermography), are more sophisticated and sensitive than the other sensors previously mentioned. The average cost of operation is three times the cost of standard color IR imagery. These sensors do have an important quality that for some applications offsets the increased cost
of the imagery.

As these sensors image thermal radiation of surface features, it is able to distinguish quite accurately between different features on the surface due to differences in mass/density and thermal emissivity. Rocks retain heat longer than soil (due to density differences) and rocks can be detected under topsoil to a depth of 12 to 18 inches depending upon rock size and soil moisture. Differences in soil moisture to these depths are also detectable by thermal IR imagery (Sabins, 1978).

Typical thermal IR sensors are sensitive to temperature differences as small as 0.1° Celsius. Thermal IR sensors have detected ancient maize fields in Arizona that were not visible on standard panchromatic photography (Berlin et al., 1977). These sensors are well-suited to surveys of small areas of probable site location.

Archaeological Use of Magnetometers

Magnetometers (both cesium and photon) have been used for locating archaeological remains for about twenty years. These sensors are used from aircraft, ship, and ground vehicles. Magnetometers vary in sensitivity, complexity, and cost. These sensors detect variations of magnetic field strengths (Parasnis, 1962). Corrections to magnetometer observations must be made for the diurnal magnetic variation of earth's magnetic field, local geology, and temperature
sensitivities of the magnetometer.

Magnetometers can detect the presence of buried architectural remains and other large types of artifacts. Smaller size artifacts cannot usually be detected if under 0.3 meter in diameter. Soil disturbance from prehistoric/historic excavation can be detected by many magnetometers (Ralph, 1973). Foundations, stone building materials, tiles, and other paleolithic/neolithic remains have been successfully located and mapped with magnetometers (Iliceto, 1971).

As magnetometers are complex and expensive, they are best utilized to survey known sites or small areas with high probability of site location. Under the control of well-trained technicians, these sensors are well suited to locating buried buildings/foundations, and other site remains without the need for excavation. Test pits are usually used in conjunction with magnetometer surveys to verify artifact type, and the particular "signature" of the artifact on the magnetometer (Muzijevic and McPherson, 1972).

Factors Influencing Archaeological Site Detection

One of the primary considerations in the use of remote sensing of archaeological sites is money. The acquisition of remote sensor imagery from aerial platforms can especially incur considerable expense. Existing remote sensor imagery of the scales of 1:3,000 to 1:7,000, is virtually nonexistent. Most governmental remote
sensor imagery is at scales from 1:20,000 or more. These scales are probably not suited to the detection of small, hunter-gatherer sites. Government photography is usually well-suited to terrain classification, vegetation mapping, and field reconnaissance positioning.

It is possible to obtain, at relatively low cost, existing aerial photography from government sources. Among the more likely Federal agencies to possess aerial photography of an area are:

1) Soil Conservation Service,
2) Bureau of Land Management,
3) Army Corps of Engineers,
4) Forest Service,
5) Bureau of Reclamation.

Cost of aerial photography and other remote sensor imagery can vary if obtained for the specific archaeological application. The scale of 1:7,000 would necessitate the acquisition of many aerial remote sensor images to cover even a relatively, small size area. The project must aim to determine the applicability and probable success rate of remote sensing before beginning image acquisition.

Besides budget restrictions, there are several other factors that affect archaeological site detection with remote sensors. The prime factor is the scale of the imagery, and the scale of the site remains to be detected. Most past remote sensing applications have been on medium to large scale architectural remains of agricultural cultures.
The resolution of remote sensors varies and the goal of remote sensing imagery should be to acquire imagery that will be able to record objects small enough to enable the interpreter to recognize sites.

If architectural remains are several hundred meters long and have left distinct soil scars, then an imagery scale of 1:20,000 is quite adequate. Housepit remains of 3 to 4 meters in diameter will need imagery from 1:3,000 to 1:7,000 to be discernible. The number of aerial platform flight-lines will increase if scales of 1:3,000 to 1:7,000 are required, thereby further increasing costs of imagery acquisition. Statistical, random sampling (transects) may be acquired to reduce costs, and still ensure a statistically reliable data base from remote sensor imagery.

Another consideration in the ability of remote sensors to detect archaeological sites is the vegetation cover over the site. In most of portions of the study area, dense grasses and/or tree cover is present. The relatively humid climate of the Willamette Valley fosters dense vegetation, especially in uncultivated areas. Not only does this dense vegetation obscure archaeological sites from aerial remote sensors, but it can prevent ground observations too. In many parts of the study area, vegetation is so dense as to even preclude walking. These areas are usually riparian vegetation stands near watercourses, probable prehistoric settlement areas. It is very likely that, except in rare circumstances, remote sensors are incapable of detecting
archaeological sites of hunter-gatherer cultures. The lack of any permanent, architectural remains greatly hampers the applicability of remote sensors to the detection hunter-gatherer settlement remains. The covering of a dense, vegetative cover further hampers this detection capability.

Soil type can also affect the ability to detect archaeological sites. The significance of soil types and climate in the detection of archaeological sites was investigated in Germany by Martin (1971). Her research pointed to the conclusions that more sites can be found in dry years than wet, and that some gravel/sand soils will be much easier to detect sites in than loess or loam soils. Porous soils (as many in Central and Eastern Oregon) were found to reveal more sites in wet years, have greater color contrasts, and in general, are easier to detect archaeological sites in. The variability of soil types in revealing disturbance is one more important consideration in remote sensor detection of archaeological sites. It might be noted here that for the study area, almost all soil was silt loam, clay loam or clay soils.

The type of remains to be detected is another factor to be considered in site detection. In general, the larger, more permanent the remains, the easier to detect and conversely, the small, less permanent the remains, the greater the potential difficulty in its detection.

One further factor that affects not only remote sensor detection
of sites but ground reconnaissance results also is the extent of soil erosion and deposition in the area. Many portions of the Luckiamute River drainage basin contained areas where extensive soil deposition has occurred, home areas had from 2 to 4 cm of soil deposited each year, other areas less. The visibility of prehistoric sites in such areas will be extremely scant. Other portions of the basin contained areas of active erosion, where fluvial processes were exposing and removing soil strata at high rates. In such areas, site visibility could be quite good under certain conditions.

**Remote Sensing Objectives**

The purpose for using remote sensors in this study were:

1) aid in ground reconnaissance position finding,

2) aid in terrain classification,

3) aid in delineation of water sources,

4) attempt to detect Luckiamute prehistoric settlement remains,

5) attempt (under budget considerations) to test the applicability of remote sensors in the detection of prehistoric sites in the mid-Willamette Valley,

6) determine other potential uses of remote sensors.
Results

The low budget allocation for this study of Luckiamute settlement-subsistence prohibited the acquisition of complete aerial photographic coverage of the study area. Through various means, several types of sensors were used on some portions of the study area. The budgetary restrictions present forced an unsystematic and stratified type of remote sensor use. U.S. Soil Conservation Service vertical, aerial, panchromatic photographs were studied using stereoscopic methods to detect possible prehistoric settlements. These aerial photographs were at a scale of 1:12,000 to 1:20,000 and had been flown over the study area for over forty years. They provided valuable data concerning flood-prone areas. They did not appear to be useful in detecting prehistoric sites. Stereoscopic examination was the primary interpretation method.

Thermal infrared imagery was acquired of known Kalapuya settlement sites by the Oregon Army National Guard (Aerial Surveillance). The imagery was acquired at 500 feet above ground level at 10:00 p.m. (after sunset). Ground reconnaissance of features mapped on the thermal infrared imagery determined that it was not able to detect the probable Kalapuya settlement sites. There was no vegetation obscuring the imagery of the cultivated field where the sites were located. This imagery was analyzed with a Digocol Color
Density Slicer, where the subtle gradations of gray were assigned colors and scale magnified several times. No discernible image features were present to enable the detection of the known Kalapuya sites. Electronic edge enhancement techniques were used, but the imagery, with a scale from 1:1,000 to 1:5,000 was unable to detect site locations.

Side Looking Airborne Radar (AN/APQ-94, Motorola) imagery was acquired of a portion of the study area. This imagery was acquired by OV-1D Mohawk aircraft of the Oregon Army National Guard (Aerial Surveillance). The imagery donated was a negative at the approximate scale of 1:250,000. Photographic enlargement and macroscopic viewing aided in the utility of the imagery. Figure 9 is a black and white photographic enlargement of the Side Looking Airborne Radar (S.L.A.R.) imagery. The area depicted is the confluence of the Luckiamute and Willamette Rivers, the scale is approximately 1:32,000.

The resolution of the SLAR is in the vicinity of 15 meters. As observed on the enlargement, metallic objects (such as roofs and railroad tracks) can be visualized at less than these dimensions. SLAR is of utility in detecting terrain relief and water-courses.

Aerial color infrared photography was acquired of some prehistoric sites detected by ground observation and reconnaissance. Figure 10 is an oblique aerial color infrared photograph of site 35PO8, acquired in January 1981. The aircraft altitude was 1000 feet (300
Figure 9. Side Looking Airborne Radar Photo Enlargement.
Figure 10. Color Infrared Photo "35P08" Site.
meters) and the photograph was acquired at 4:00 p.m. to obtain a low sun angle (aiding in the detection of soil disturbance). On the photograph, the site is located in the small triangular shaped clearing. The vegetation is rye-grass, burned September 1980. In the narrow portion of the clearing, several circular and/or semi-circular shapes (approx. 3 to 4 meters diameter) apparent on the soil surface. Although this area is the location of over 300 surface lithic crypto-crystalline flakes, ground reconnaissance could not detect the origin of these shapes. It is possible that these soil markings are caused by agricultural activities, previous construction in the area, or are pit-house remains. Until test excavations are performed (scheduled for late spring 1981) then no conclusive data exist to explain the soil markings.

Figure 11 is also an oblique aerial color infrared photograph of the probable prehistoric site along the old river course of the Luckiamute River. No apparent soil disturbance markings or anomalies in vegetation are apparent on the photograph or observed on ground reconnaissance. Even with the low sun-angle (photo acquired Jan. 1981 at 4:05 p.m. at 1000 feet altitude) no changes in microrelief are apparent. The repeated plowing over the years has apparently modified the topsoil into a fairly homogenous composition. The repetitive plowing of agricultural fields in the study area over the years, along with the application of fertilizers, will in most instances erase
Figure 11. Color Infrared Photo - Luckiamute River Site.
the possible identification factors of prehistoric sites. As farmers
desire a homogenous topsoil layer with good soil aeration, high
organic/inorganic nutrients, and low soil compaction--the likelihood
that relatively localized and small variations of organic soil composi-
tion resulting from decomposed aboriginal settlements is greatly
reduced. It is entirely possible to view the interaction of site detecta-
bility by remote sensing and agricultural practices as working against
each other.

The other factor that hampers remote sensing detection of pre-
historic settlements in the Willamette Valley is that if the terrain has
not been cleared and kept cultivated, then the vegetation is so dense
(even in winter under deciduous trees) that the sensors discussed in
this paper are incapable of imaging them. Unless the site were of
large dimension and constructed of permanent building materials
(such as masonry/rock), it is extremely unlikely that aerial remote
sensors will be of much value.

Areas of the Willamette Valley where aerial remote sensors
would have a great probability of detection would probably be where
aboriginally created prairie-grassland has not been repetitively
plowed but field burned yearly instead, to prevent the growth of
riparian vegetation. These type of areas in the Willamette Valley
are probably rare, and most likely are either in flood-prone areas
where soil deposition has occurred or on hillslopes and crests where
either lack of water or gradient discouraged prehistoric settlement.

Ground based remote sensors such as portable magnetometers are of potential utility in the mapping and delineation of inhabitation spots in known sites. While no funding was approved for the use of these sensors, it is probable that their utility in detecting the remains of camas ovens, fire hearths and pit-houses is high in areas where prehistoric surface cryptocrystalline material is observed and where geographic factors were favorable for site location.

Discussion of Remote Sensing Results

Aerial remote sensors such as vertical panchromatic photography, thermal infrared and color infrared imagery, and side looking airborne radar proved in this study to be ineffectual in the detection of prehistoric hunter/gatherer settlements. The combination of dense vegetation and repetitive agriculture plowing tends to greatly reduce the utility of these remote sensors. In addition, the nature of the sites, i.e., their lack of large architectural dimensions and permanent building materials do not present readily detectable remains as do many prehistoric agricultural cultures (such as is present in Chaco Canyon).

The sensors used in this study did prove effective in aiding in terrain classification, and in detecting the previous courses of rivers. It is suggested that the utility of the Soil Conservation Service's
vertical aerial photography (in stereo-pairs) was most cost-effective. The donation of the SLAR and thermal infrared imagery by the Oregon Army National Guard was helpful, but might not be readily available in other regional archaeological assessments.

The utility of aerial photographs in field reconnaissance is good, aerial photos greatly aided in location-finding and reconnaissance transect determination. Previous use of aerial photography for these processes was discussed by Aikens et al. (1980).

It is suggested that in central and eastern Oregon, aerial remote sensors may be more successful in prehistoric site detection. The lower annual precipitation, thinner vegetation and increased soil porosity are factors which would favor site detection. As suggested by Martin (1971), the optimal time for these porous soils to reveal organic anomalies left by prehistoric occupation would be when soil stress in moisture is greatest, such as in late summer. Additionally, the lack of repetitive agricultural plowing would also tend to favor site detection.

It is also likely that many historic archaeological sites could be detected by remote sensors in the Willamette Valley because of their increased use of permanent building materials and larger dimensions.
V. GROUND RECONNAISSANCE

Objectives

The objectives of the ground reconnaissance were limited. The chief objective was to determine the settlement-subsistence patterns of the Luckiamute through prehistoric site location. As it was not possible to conduct a complete reconnaissance or even a statistically random sample, a series of ground reconnaissance trips were conducted in areas deemed to have a high probability of settlement. Time, transportation, access, and personnel were limited.

The areas of ground reconnaissance were biased in that they were of areas preselected to have the high probability of prehistoric settlement. Future research without the constraints present in this one might well consider using a random sampling for determining areas for ground reconnaissance.

The determination of the location of sites that might be present in the study area was another objective. The location of these prehistoric sites was also important to the determination if remote sensors were detecting them.

Methodology

Areas selected for ground reconnaissance in the study area, were selected according to these criteria:
1) within 100 meters of water source,
2) slope of 10° or less,
3) private property owner's permission to perform ground reconnaissance.

Surface reconnaissance was conducted by the author, experienced in reconnaissance, testing, and excavation in prehistoric/historic archaeology. Cultural material observed on the surface was described, photographed, and mapped. No cultural material was collected.

When possible, fields were viewed after being plowed when ground visibility was good, although disturbed. Since no testing by excavation and no diagnostic artifacts were noted, the assessment of the significance of identified archaeological sites in terms of National Register criteria is beyond the limits of this regional assessment. It is probable that all the located sites in the study area are of potential National Register significance.

Interviews were conducted with most of the property owners, and in most cases they knew of the locations of surface artifacts. Many had grown up in the area and were familiar with some aspects of Kalapuya settlement. Most of the property owners were very cooperative and encouraging.

Transects were walked, starting about 5 meters from water courses and then working away from the original transect, every 10
to 15 meters. Over forty field hours of ground reconnaissance were conducted. In most cases, recent rain had fallen on the plowed fields, washing soil off of cryptocrystalline objects, further enhancing surface visibility.

Results

Seven probable prehistoric sites were visually located by surface reconnaissance. These surface reconnaissance trips were conducted in November and December 1980. Surface vegetation is less in this season and most of the fields had been recently plowed for winter crops, surface visibility was good.

A detailed description of the sites is given in the Appendix, under the Oregon Archaeological Survey forms. In general, two sites were located on the floodplain of Frazier Creek (38BE35 and 35BE36), and were probably seasonal late-spring/early-summer sites. These two sites were observed to be flooded in January 1981 and soil data indicates that it is common for that area to flood in winter months.

The other five prehistoric sites were located off the floodplain, on alluvial terraces. Four of these were located on Soap and Berry Creeks (35P08; 35P09; UTM 8100, 5300; UTM 8200, 5300). The last site was located on an alluvial terrace overlooking a remnant course of the Luckiamute River. These five may have been year-round settlements, or winter village sites.
The sites were all located in cultivated fields. The dense vegetation near water bodies precluded any soil visibility, thereby adding another possible bias to the reconnaissance. It is probable that the primary determinant in most of these surface reconnaissances was surface visibility. The location of these sites, in some ways, adds further evidence of the settlement pattern of the prehistoric inhabitants of the study area. Many of the landowners in the area adjacent to Soap Creek, and the Luckiamute River were familiar with other, unrecorded prehistoric sites. At least four reported sites are located on the Luckiamute River and an equal number on Soap Creek, and the Willamette River. Several reported prehistoric sites are possibly located in the rapidly, urbanizing North Albany area.
VI. CULTURAL RESOURCE MANAGEMENT PRIORITIZATION

The study area possesses the remains of a now extinct culture—the Luckiamute. The entire heritage of these people is possessed in the remains left by them over the centuries. As most of the land in the study area is privately owned, the fate of these remains is in the hands of the private land owners. Many of the landowners contacted in this study are open to archaeological testing and excavation being conducted on their land. Many are committed to preserving these sites by maintaining the present land use on them.

The greatest danger to the prehistoric archaeological sites in the study area is urbanization. The North Albany area in particular is growing rapidly, and probably many sites have already been negatively impacted there. The state owned property around Adair Village can be protected by existing state and federal cultural resource management laws.

The settlement pattern prediction map (Figure 8) can serve to delineate sensitive cultural resource areas. Figure 12 depicts the prioritization of the study area for prehistoric site preservation. It is based on the conclusion that the Regional Archaeological Assessment System has provided a generally reliable estimate of site locations. Three priority zones are depicted and are based on the regional assessment.
Figure 12. Cultural Resource Management Priority Areas.
Priority 1 areas consist of known prehistoric site locations and/or probable Riparian (year around) sites. It is recommended that as long as present land use activities are followed no further negative impact is likely to occur. If future changes in land use dictate soil disturbance, then testing of the affected area should be performed. Testing to include the use of a 100% ground reconnaissance and test pit excavation. Test pits should be of sufficient quantity and depth to insure adequate sampling of the impacted area. If prehistoric cultural materials are recovered, alternative locations for the new activity should be considered, and/or a thorough (50% to 70%) excavation should be conducted. Any area that has been confirmed as a prehistoric site in Priority 1 areas should be protected from damage under the advice of a consulting professional archaeologist.

Priority 2 areas consist of probable seasonal and/or temporary habitation sites located on the valley floodplain. It is recommended that as long as present land use activities are followed, that no negative impact is likely to occur. If in the future, land use is to be changed so that further soil disturbance is necessary, then testing should be performed as described in Priority 1 areas. The excavation needs should be determined by a consulting professional archaeologist.

Priority 3 areas are located on hillslopes, existing grassland/prairies or riparian vegetation, and in areas of possible temporary habitation. If land use changes are considered that require soil
disturbance, then a ground reconnaissance after vegetation has been cleared is suggested to determine if prehistoric material is present. If artifacts are observed then testing is recommended as described in Priority 1 areas. If no artifacts are observed, land use change should proceed. If during excavation for construction any prehistoric cultural materials are found, a consulting professional archaeologist should be directed to assess the possible importance of the site. No further construction should continue until the archaeologist determines the site's importance. Upon recommendation of the archaeologist, construction may or may not continue. It may be necessary to follow excavation procedures as outlined in Priority 1 Area recommendations.

Private property owners will of course be able to choose whether they will observe these recommendations.
VII. SUMMARY

The study area contains landforms and vegetation types that could have provided year-round subsistence for the Kalapuya. As ethnographic data reveal, there were probably several bands of the Luckiamute grouping of the Kalapuya who resided in the study area. Numerous prehistoric sites have been located in the study area and it is very probable that many more are present. The Regional Archaeological Assessment System has predicted the location of known and projected sites based on polythetic settlement factors. The study area would have been desirable for seasonal and year-round habitation by hunter/gatherer societies such as the Luckiamute. It is probable that the study area was inhabited during the late Pleistocene by hunter/gatherer cultures before the arrival of the Kalapuya. The only reliable method of determining the real significance of the prehistoric archaeological sites in the study area is to undertake excavation and analysis of artifacts. This method is expensive and not required. In the future it may be feasible to undertake excavations of the prehistoric sites in the study area and to refine the understanding of their significance. The antiquity and possible functions of the located sites could not be determined by surface debris. Given the limited knowledge of mid-Willamette Valley prehistory, all of these prehistoric sites must be considered potentially eligible to the National Register.
This study has contributed to the amount of knowledge concerning the Luckiamute (and Kalapuya) settlement patterns and their probable subsistence patterns. The systematic approach to prehistoric settlement pattern prediction used in this study could not be thoroughly tested. Preliminary testing through ground reconnaissance indicated it was successful in predicting prehistoric settlements. Further use of this systematic approach will provide archaeologists with an accurate estimate of prehistoric settlement patterns, in any area. As further information about the prehistory of the Willamette Valley becomes available, refinements can be made to this system's prediction. This study has contributed to the amount of knowledge concerning the Luckiamute (and Kalapuya) settlement patterns and their probable subsistence patterns.
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APPENDIX
Oregon Archaeological Survey
University of Oregon, Museum of Natural History

County: POLK  Site No. 35P08  Type of site: Surface Lithic Scatter
Cultural Affiliation: Mid-Willamette Valley, Kalapuya
Location: UTM Coords. E 833645, N 4932500 (Lewisburg Topo Sheet: 1:24000 or Albany: 1:62500)
Site centered on coords above, on alluvial terrace above Soap Creek. Site is west of Southern Pacific RR tracks.

Owner and address:
Present occupant: same  Attitude toward excavation: favorable

Site description (midden, house pits, etc.) Site is about 150 meters East-West, 25 meters North-South. Over 100 cryocrystalline flakes were observed on surface of this area. Owner has collected over 150 projectile points, scrapper frags., drill points.

Area of occupation: Alluvial terrace above Soap Creek (10 to 20 meters above)
Depth and character of fill: unknown
Vegetation cover: grasses
Present condition: plow zone surface disturbance, one or two small pits dug by owner.

Material previously collected and owner: see description
Material collected by survey: none

Recommendation for future work: testing and excavation

*Site description cont’d.
Several pestles, grinding bowl, killed camas digging stick handle, lithic net sinkers, lithic smoking mechanism, lead musket balls, possible 1855 dime, trade bead (blue), obsidian, red jasper, chert flakes, some retouched. Historic component on NW corner of site area—with glass frags., ceramic frags., white earthenware frags., stove metal frags. Owner believes it had been a contact period site.

Photograph note: 1+2

Recorded by: James Bell  Date: Dec. 1, 1980
Dept. of Anthropology, OSU
County: POLK  
Site No: 35 P 9  
Type of site: Surface Lithic Scatter

Cultural Affiliation: Mid-Willamette Valley (Kalahuya)

Location: UTM COORDS: 3295 E, 495280 N (1:24000 Lewisburg Topo Quad, USGS)

- Scatter centered on coord. above, about 125 meters East to West, 25 meters North-South, on alluvial terrace 25-40 meters from Soap Creek.

Owner and address: 

Present occupant: same  
Attitude toward excavation: unknown

Site description: (midden, house pits, etc.) Site in plowed field. Excellent visibility. Over 50 black obsidian flakes and cores, 25+ red jasper flakes, pos. pinto frags.

- Numerous FCZ two lancelet point frags, pos. bone frags, 10 white cryptocrystalline frags.

Area of occupation: Alluvial terrace above floodplain of Soap Creek. Legs frags.

Depth and character of fill: unknown

Vegetation cover: under cultivation

Present conditions: plow zone, otherwise unknown

Material previously collected and owner: Two lancelet point frags, pos. obsidian cobbles.

Material collected by survey: none

Recommendation for future work: Testing with permission of landowner.

Photograph not: none

Scale: 1:24000

Recorded by: James Bell
Date: Dec. 1, 1980
Dept. of Anthropology, OSU
Oregon Archaeological Survey
University of Oregon, Museum of Natural History

County: Benton Site No: See 35 Type of site: SURFACE LITHIC SCATTER
Cultural Affiliation: MID-WILLAMETTE VALLEY
Location: SW¼, NE¼, SEC. 4, T11S, R4W Albany Quad 15'
UTM: 92620 E, 494330 N
(10-12 meters north of Fraser Creek)

Owner and address: Independence Hwy., Albany, OR 97321

Attitude toward excavation: unknown

Site description: (midden, house pits, etc.) surface lithic scatter of 12 chert flakes, 7 obsidian flakes, 15 red jasper cores/flakes, 3 white cryptocrystalline flakes, 4 broken pestle frags., 1 hammerstone frag., 1 ground-stone bowl frag. (12.5cm x 2.0cm thick), numerous fire-cracked rocks.

Area of occupation: 35-40 meters S/N, 10-12 meters N/S, centered on coords. above

Depth and character of fill: in plow zone, unknown

Vegetation cover: cultivated grasses/wheat

Present condition: disturbed by plowing, otherwise unknown

Material previously collected and owner: unknown

Material collected by survey: none

Recommendation for future work: testing with permission of landowner

Photograph nos:

Recorded by Jim and Nancy Bell
Date: Nov. 6, 1980
Dept. of Anthropology, O.S.U.
County: Benton  Site No: 358E32
Type of site: Surface lithic scatter

Cultural Affiliation: Mid-Willamette Valley

Location: SW 1/4 NW 1/4 Sec. 4, T11S, R4W, Albany, USGS 15'
UTM Zone 10: 8590 E, 494350 N (10meters north of Frazier Creek)

Owner and address: Independence Hwy., Albany, OR 97321

Present occupant: Same

Attitude toward excavation: Unknown

Site description: Site located on surface of plow zone. Surface scatter of numerous cryptocrystalline flakes (some utilized). Scatter approx. 5 meters in radius, centered on coord. above. Several white earthenware & glass frags. in north part of scatter.

Area of occupation: Approx. 5 meters radius, centered on coords.

Depth and character of fill: Unknown-located on seasonal floodplain.

Vegetation cover: Cultivated grasses

Present condition: Disturbed plow zone

Material previously collected and owner: Unknown

Material collected by survey: None

Recommendation for future work: Testing with permission of landowner

Note: Flakes of red jasper, gray chert, and obsidian.
Two fragments of pestles found. Prob. distal radius or ulna frag. (human) found on surface. Estimate 30-40 lithic fragments on surface. Approx. 1-15 white earthenware frags., and glass frags. found.

Recorded by Jim and Hillary Bell
Date: Nov. 3, 1980

Dept. of Anthropology, O.S.U.
Type of site: Prehistoric surface lithic scatter

Location: Located on alluvial terrace above Berry Creek, UTM COORD. 4210E, 49533N, (Lewisburg Topo. Quad. 1:24000)

Site description: Surface lithic scatter of approx. 30 or more cryptocrystalline flakes, about 10 meters from edge of terrace, in area under cultivation. Site is about 20 meters long, 5 meters wide.

Area of occupation: North of bend in Berry Creek.

Vegetation cover: Seasonal cultivation

Present condition: Unknown

Material previously collected and owner: Unknown

Material collected by survey: None

Recommendation for future work: None

Photograph nos.

Scale 1:24000

Recorded by: James Bell
Date: Feb. 7, 1981
Dept of Anthropology, O.S.U.
# Oregon Archaeological Survey

**University of Oregon, Museum of Natural History**

**Site No. 35PO**

**Type of site:** PREHISTORIC SURFACE LITHIC SCATTER

**Cultural Affiliation:** KALAPUYA/MID-WILLAMETTE VALLEY

**Location:** Located on alluvial terrace adjacent to Berry Creek, UTM coords. 8170E, 432320N (Lewisburg Quad, 1:24000).

**Owner and address:** Airlie Rd., Monmouth, OR 97361

**Present occupant:** same

**Attitude toward excavation:** unknown

**Site description:** (midden, house pits, etc.) Surface lithic scatter of over 150 cryptocrystalline flakes/cores. Numerous ground stone bowl frags., pestle frags., bone frags.

**Area in cultivation with excellent soil visibility:**

**Area of occupation:** entire "U" shaped alluvial terrace, between bends of Berry Creek.

**Depth and character of fill:** unknown

**Vegetation cover:** under seasonal cultivation

**Present condition:** unknown

**Material previously collected and owner:** unknown

**Material collected by survey:** none

**Recommendation for future work:** testing with permission

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**Scale:** 1:24000

(when square represents a section, 1" = 1/4 mile)

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**Recorded by:** James Bell

**Date:** Feb. 7, 1981

**Dept, of Anthropology, O.S.U.**
County: POLK  Site No.: 3570  Type of Site: Prehistoric surface lithic scatter

Cultural Affiliation: Kalapuya/mid-Willamette Valley

Location: On an alluvial terrace adjacent to old river meander of Luckiamute River.

UTM coords.: 3205E, 5515N (Lewisburg & Monmouth Topo. Quads. 1:24,000)

is the approx. center of site. North to south 175 to 200 meters, E-W 25 meters.

Owner and address: Pacific Hwy. West, Monmouth, OR 97361

Present occupant: same

Attitude toward excavation: favorable

Site description: (midden, house pits, etc.) recently cultivated field with surface scatter of over 300 cryptocrystalline flakes. Occasional bone frags., 5 pestle frags., one hammerstone frag. Lithic material mainly red jasper, obsidian, and chert.

Area of occupation: along the edge of alluvial terrace, within 25-30 meters of edge.

Depth and character of fill: unknown

Vegetation cover: under seasonal cultivation

Present condition: unknown

Material previously collected and owner: unknown

Material collected by survey: none

Recommendation for future work: testing with permission

Photograph no.: 914 208

Recorded by: James Bell

Feb. 7, 1981

Dept. of Anthropology, U.O.U.